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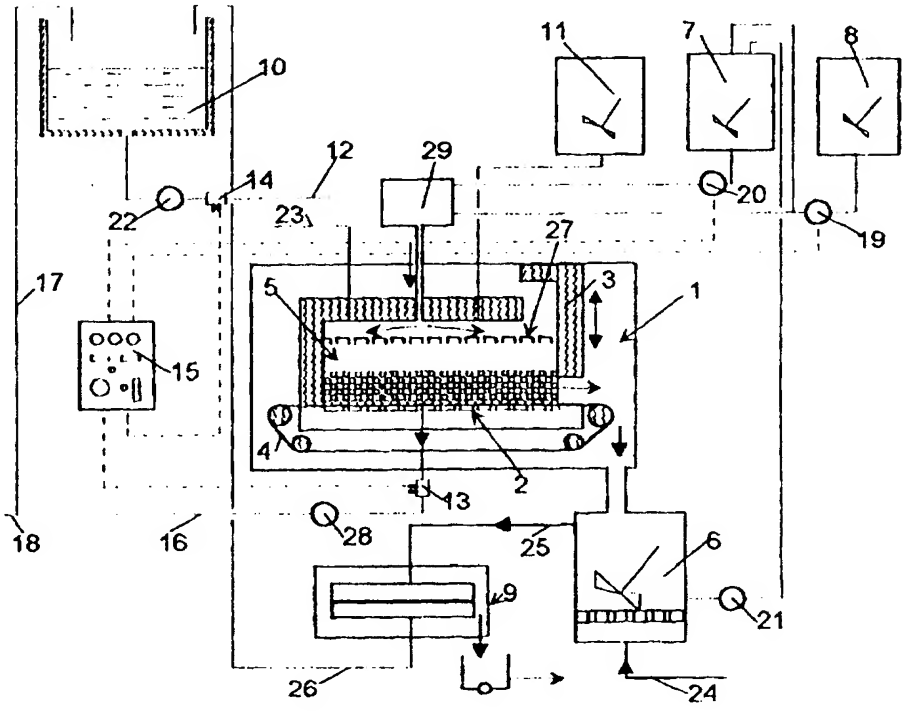
(54) Title: APPARATUS FOR LIQUID PURIFICATION

(57) Abstract

The invention concerns a liquid purifying apparatus that bridges the gap between prior art sand filters as applied mainly in the field of water treatment and pressure leaf, candle and cartridge filters as well as filter presses for filtration and purification in the liquid processing industries. In contrast to prior art sand filters where static beds of granular material are regenerated by baskwashing techniques, the granular beds of the present invention are transported out of the filter container by a moving filter belt into an external bed-regenerating device after which the regenerated and reactivated bed is reused by dosing to the filter container with the incoming fluid to be purified. It is proposed to simultaneously dose a variety of active powdered adsorbents, such as activated carbon, molecular sieves, etc., to the purifier influent to remove specific dissolved contaminants, whereby the surface charge and particle size of this material are designed to adhere to the surface of the particulate matter of the bed. The dosing of active adsorbents and the particulate matter of the bed is controlled by a programmed microprocessor receiving input process data from influent and effluent instrumentation. A further feature is the provision of apparatus for feeding prefabricated sections of filter media such as membranes, non-woven and woven materials into the filter container for application in fully automatic operation throughout the whole spectrum of industrial and communal liquid purification processes.



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APPARATUS FOR LIQUID PURIFICATION

Description

This invention concerns apparatus for the purification of liquids. By purification is meant the removal of unwanted suspended, colloidal or dissolved substances from a liquid.

The prior art of apparatus to achieve this consists of a large variety of generically related filters that ulilize over-pressure and/or under pressure to provide the necessary pressure difference for filtration.

For the purification of liquids, filter presses or pressure leaf, candle and cartridge filters (pressure vessels containing such elements) are mainly utilized. Such liquids are chemicals, pharmaceutical products, beer, wine, sugar, oils and fats, petroleum products, etc. Their purification normally involves some form of "in-depth" filtration or purification process, whereby the liquid to be purified is either passed through or forms thereby a bed of particulate purification aid whereby the separation mechanism is mostly a combination of sieving-action and adsorption. The purification aids that are used include diatomaceous earth (kieselguhr), bleaching earth, ion-exchange resin, activated carbon, etc., all normally in powder form. The solid residues can rarely be regenerated and their disposal poses an acute environmental problem.

On the other hand, using apparatus of the nutsche-type filter in the form of open or closed containers, water is filtered by means of gravity or over-pressure on a large scale by means of thick, static beds of coarse granular material (e.g. sand). These beds are regenerated after filtration by backwashing techniques and reused. Although this method is suitable for the filtration of relatively clean surface and ground water, it is wholly unsatisfactory for the purification of industrial and domestic effluent. The reason is that the back-washing and regeneration techniques of prior art sand filters

- are inadequate for washing out most of the large variety of suspended solids contained in industrial liquid effluent

and

- produce excessive amounts of contaminated backwash liquid.

Added to this, the static nature of the beds is unsuited for the filtration of particulate matter, as large sections of the bed remain unused and the necessity for utilizing relatively coarse granular material comprising the beds for removing organic and inorganic contaminants in solution precludes on economic grounds the possibility of utilizing the extensive range of available adsorbents comprising such materials as activated carbon, anthracite, ion-exchange resin, bleaching earth, molecular sieves, etc. required for removing specific contaminants in the field of effluent and water purification.

The goal of this invention is to further develop the art and science of "in-depth" filtration utilizing beds of loose material for the purification of liquids such as processed by the

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substances such as polyelectrolytes, is pumped using means 22 from reservoir 10 into container 5. Simultaneously, suspensions of bed material recycled from regenerator 6 and activated powdered adsorbents are dosed using means 7/20 & 8/19 under pressure to a mixing section 27 of the delivery conduit 12 controlled by microprocessor 15 from input data from instrumentation 14 and 13 in the delivery conduit 12 and the filtrate conduit 16 respectively. The liquid quality and process parameters (concentration) controlled include turbidity, pH, hardness, chlorinated organics, mineral oil, heavy metals, phosphates, nitrates, etc. as well as variables such as pressure difference and through-put. Filtrate is recycled, if necessary by means of a suction/vacuum pump (28), through conduits 16 & 17 to reservoir 10 until the concentration of contaminants in the filtrate is reduced to a set level as measured at 13. Filtrate flow is switched to conduit 18 whence it is collected in a reservoir not shown. On either reaching a pre-set pressure differential across the bed or a pre-set upper level of contaminant concentration as measured by instrumentation 13, pump 22 and all dosing apparatus are shut down and external gas is fed through conduit 23 to container 5 whereby the residual liquid in the chamber and bed is removed, after which the dependent rim portions 3 of container 5 are raised and the bed is transported by the filter belt 4 and discharged into the bed regenerator 6. The dependent rim portions 3 are lowered onto a fresh section of belt and the cycle described above is repeated. The regenerator 6, in effect, removes adsorbate and entrapped particulate matter (ultrasonics, turbulence, diffusion, etc.) from the internal and external surfaces of the granular material, which may be an adsorbent itself, thereby regenerating, cleaning and restoring the desired activities to these surfaces. Clean liquid is introduced to 6 through conduit 24 and by means of hydraulic classification action the adsorbate and particulate matter are removed through conduit 25 to filter 9 to recover a solid waste. Depending on its nature, the recovered fluid is recycled to 10 or reprocessed. Not shown are the means for introducing and removing the bed regenerating and reactivating fluids to and from bed regenerator 6.
Fig.2 is a schematic representation of a partly sectioned elevation of media feeding mechanisms of the invention. Prior art filters have the disadvantage that a replacement of filter media involves lengthy shut-down periods and often excessive manual manipulation. A further goal, therefore, of the present invention is to provide the means for automatically and quickly fitting a large variety of prefabricated materials (e.g. menbranes, paper, carton, etc.) to fulfill the requirements of the liquid processing industries. Pressure cylinders 215, normally taking the form of hydraulic or pneumatic rams are provided for actuating the dependent rim portions 3 of the filter container 5 in the vertical direction for bed removal and container closure.
A plurality of rolls of filter media 209, 210 are provided for feeding sections onto the lower filtrate chamber 2. Drive rollers 220, 221 located on the surface of the media rolls and actuated by a brake/clutch mechanism 225 driven by the filter belt 217 through idle

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is known. This and other pertinent information are entered into the programmed microprocessor 15 and the following sequence of operations proceeds fully automatically:
Start:

1. A section of 10 micron retention filter paper from 212 is automatically fed into the filter container.
2. The dependent rim portions of the container 5 are lowered to seal the section of paper lying on the filtrate chamber.
3. The differential pressure controller 404 establishes a preset pressure differential between the chamber sealing space 402 and the filtrate chamber 403.
4. With the container 1 vented, approx. 15 l/m² of the suspension are introduced to the top container 5 and distributed over the surface of the sealed section of filter paper.
5. Compressed gas is introduced to the top chamber through control valve 407, whereby the gas pressure and flow controllers 405/6 control and indirectly establish the filtration characteristics of the suspension by measuring the volumetric flow of gas in the top container 5. A sample of filtrate flows through a turbidity meter 410 to record the degree of clarity of the filtrate.

.....

The computer 15 chooses the filtration mode and type of medium:

Mode: precoat with medium speed diatomite with 1% body-feed

Medium: 20 micron polyestermonofil section of belt

.....

6. The depending rim portions (3) are raised and the filter paper is discharged.
7. The 20 micron belt section is automatically positioned in the container 1.
8. Steps 3,4,5 are repeated with a liquid of known filtration characteristics.

9a. Result of permeability test: negative. The section of belt is subjected to a standard cleaning/regeneration procedure after which steps 3,4,5 are repeated.

9b. Result: positive. With the container 1 vented, approx. 20l/m² of diatomite suspension are introduced to the top container 5.

10. While the chamber 5 is being pressurized with gas, suspension to be filtered with 1% diatomite body-feed is introduced under pressure through valve 407. The feed rate is controlled by a pressure differential controller 405. Filtration proceeds.
11. On reaching a preset pressure differential, filtration terminates. Valve 401 shuts.
12. Valve 407 opens. Gas forces rest suspension through the filter cake.
13. Gas flow controller 406 signals a break-through of gas through the filter cake.
14. Valve 407 shuts.
15. The valve 408 opens. A pre-set quantity of wash liquid is fed to the container 5.
16. Valve 408 shuts. Valve 407 opens. Gas forces wash liquid through the cake.
17. The flow controller 406 signals a break-through of gas through the filter cake.

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CLAIMS

1. A liquid filtering apparatus consisting of a container with an internal lower horizontal, pervious base supporting a bed of loose, granular filter media;
whereby the base has the form of a filtrate drainage member or chamber fitted with an outlet nozzle for filtrate and a inlet nozzle for backwash fluids
and whereby the upper part of the container has an inlet connection for contaminated liquid at or above atmospheric pressure and an outlet connection for backwsh fluids, *thereby characterized,*
that the container (1) is divided horizontally at the level of the pervious horizontal base (2), whereby the dependent rim portions (3) of the top section of the container (5) are movable in the vertical direction to facilitate the removal of the bed from the container and whereby the container (5) is fitted with an inlet connection for contaminated liquid and the base (2) is fitted with an outlet nozzle for filtrate.

2. A liquid purifying apparatus according to Claim 1, *thereby characterized,* that a section of movable web of filter medium (4) is interposed between the pervious, horizontal support base (2) and the vertically movable dependent rim portions of the top section of the container (5), thus sealing a section(s) of the web at the periphery in the closed position, whereby in the raised position the filter bed after the purification operation is transported out of the container 1.

3. A liquid purifying apparatus according to claims 1 and 2, *thereby characterized,* that taken alone or in combination,

the bed after the purification operation is discharged into a bed regeneration device (6), whereby the bed material is regenerated and/or cleaned and recycled to the top container (5) of the filter for reuse;

the bed after the purification operation is discharged into a bed regeneration device 6, whereby the material of the bed is regenerated and/or cleaned and reactivated after which and before the purification operation, the bed is recycled to the top container (5) of the purifying apparatus (1) for reuse;

the bed material, after regeneration and/or cleaning and reactivation, is first recycled to a dosing device (7/20) that before the purification operation feeds the entire bed to the top container (5) of the purifying apparatus (1);

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characterized, that taken individually or in combination,
the filter web takes the form of an endless belt consisting of a plurality of sections (201, 202, 203) providing different degrees of filtrate quality or consisting of different materials;

the filter web takes the form of an endless belt consisting of a plurality of sections, whereby means (204, 205, 206) are provided for individually removing and replacing each section and automatically locating each section on the pervious, horizontal support base (2) by means of one or more electronic sensors (218) fixed to the frame of the apparatus and one or more electronically sensitive inserts (219) in the edges of the belt.

the filter web takes the form of a filter belt, whereby sections of it are used as support and transport means for introducing strips of pre-fabricated filter material from storage rolls located externally to the purification apparatus 1, whereby the strips are fed onto the filter belt by means of a belt-driven roller combination (207) and whereby after a set length of filter material has been fed onto the porous base (2) the strip is cut to size by the slitting device (208), after which the dependent rim portions of the container (5) are lowered onto the strip of filter material and the section of support belt against the pervious, horizontal support base 2;

the filter web takes the form of a filter belt, whereby sections of it are used as support and transport means for introducing strips of pre-fabricated portions of filter material from storage cassettes (225) located externally to the purification apparatus 1 from where single strips of filter medium (211, 212) are mechanically fed by the feeding mechanism (214, 213) and belt-driven roller combination (207) onto the pervious filtrate base (2) after which the dependent rim portions (3) are lowered to seal the strip of filter material and section of support belt against the pervious, horizontal support base (2);
the filter web takes the form of a filter belt, whereby sections of it, sealed by dependent rim portions 3, are used as support for dosed layers of suspension of filter aid fibres such as cellulose, glass, asbestos, etc. or powders such as diatomaeous earth, perlite, molecular sieves, etc. from an external dosing means (11), after which the pressure difference between the container (5) and the filtrate chamber (2) is increased with the introduction to the container (5) of liquid to be purified from a reservoir (10) and optionally a dosed quantity of a suspension of adsorbent or filter bed material from dosing means (7), whereby the formed layer of filter aid acts as either the primary filter medium or as a support and polishing or security layer for removing any particulate or dissolved matter escaping from the formed or forming bed;

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filtration to achieve a manually chosen menu of results;

means in the form of a programmed microprocessor (15) that receives data from instrumentation such as (405, 406) and/or (13) and/or (14) regarding the filtration characterisics of any given section of medium sealed within the purifying apparatus (1) and if necessary aautomatically initiates a medium regeneration and/or a renewal operation;

means in the form of a gas pressure differential controller (405), a gas flow controller (406) and a gas flow control valve (407) provided in a compressed gas conduit (403) leading into the upper portion of the container (5) to control and record the volumetric gas flow into the said container and thereby provide a measure of the rate of filtration of a layer of liquid with known filtration characteristics lying on a section of sealed filter medium with unknown filtration characteristics supported by a horizontal pervious support base (2);

means in the form of a programmed microprocessor (15) that receives data from instrumentation such as (405, 406) and/or (13) and/or (14) regarding the filtration characterisics and quality of a liquid processed by the purification apparatus (1) and chooses and positions the type or types of media and mode of purification and/or filtration to achieve a manually chosen menu of results;

means in the form of a programmed microprocessor (15) that receives data from instrumentation such as (405, 406) and/or (13) and/or (14) regarding the filtration ...s of any given section of medium sealed by the container (5) and if necessary : automatically either initiates a regeneration and/or renewal operation.

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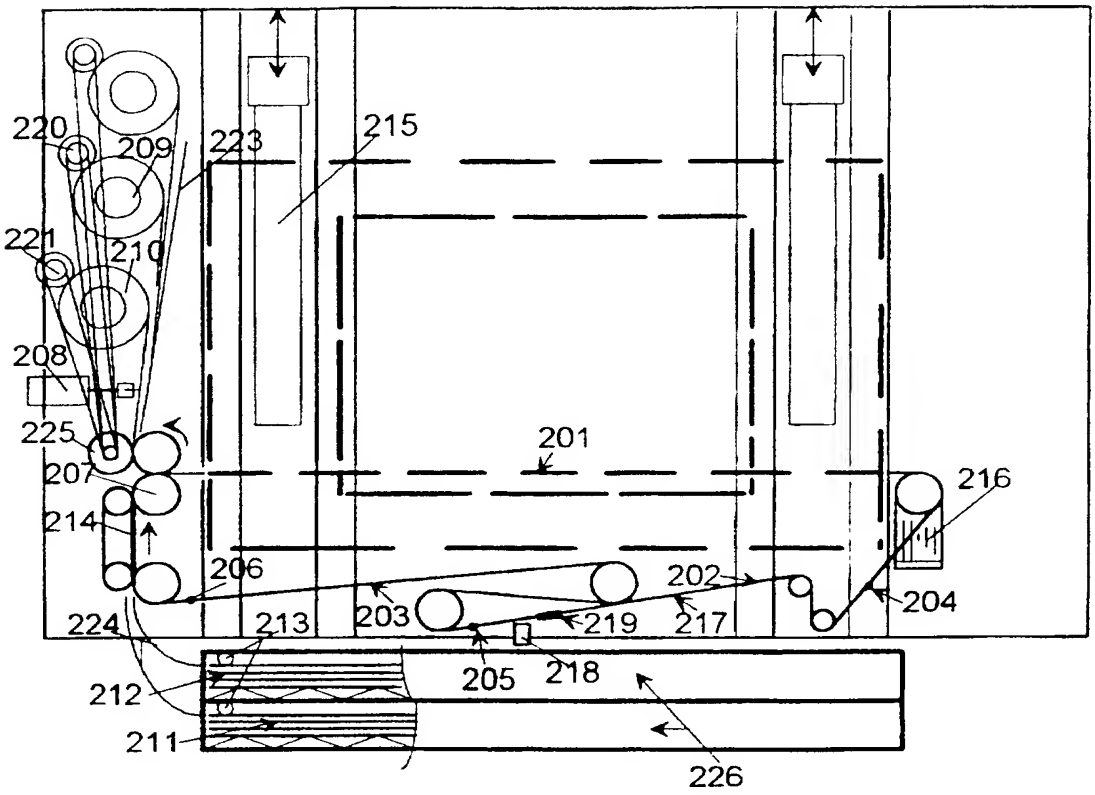

Fig.2

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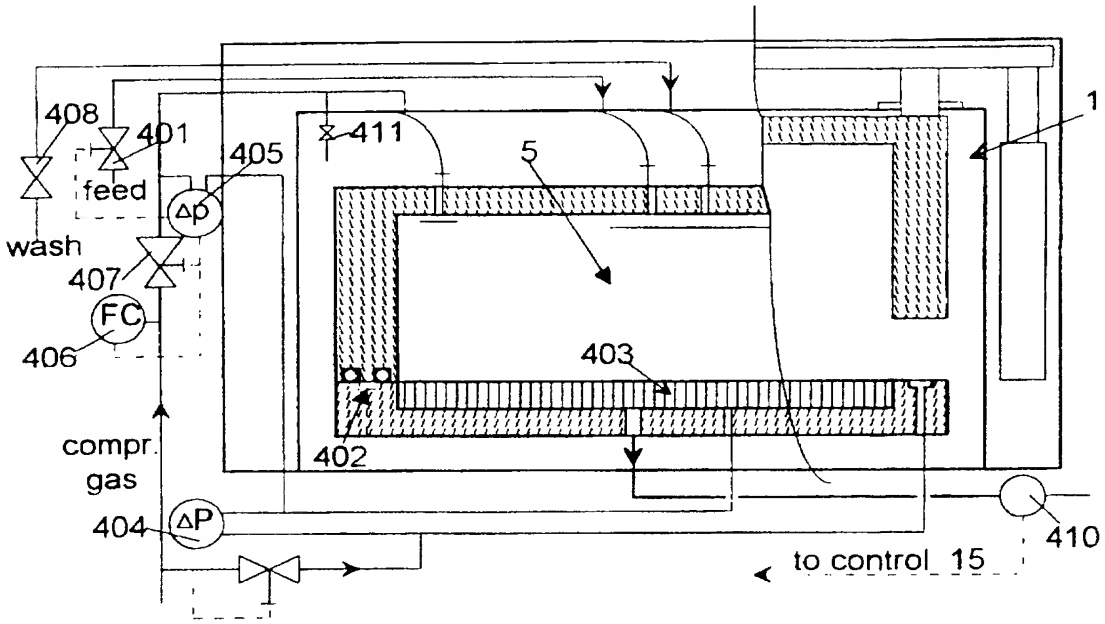

Fig.4

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INTERNATIONAL SEARCH REPORT

International Application No.
PCT/AU 96/00442

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: B01D 24/46, 29/96 41/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC B01D 24/46 29/96 41/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU : IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB A 876722 (HIRS) 12 December 1958	1-7
X	GB A 1058530 (HIRS) 15 February 1967	1-7

☐ Further documents are listed in the continuation of Box C

☐ See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
22 October 1996

Date of mailing of the international search report
30 OCT 1996

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Patent Abstracts of Japan

PUBLICATION NUMBER : 03042006
PUBLICATION DATE : 22-02-91

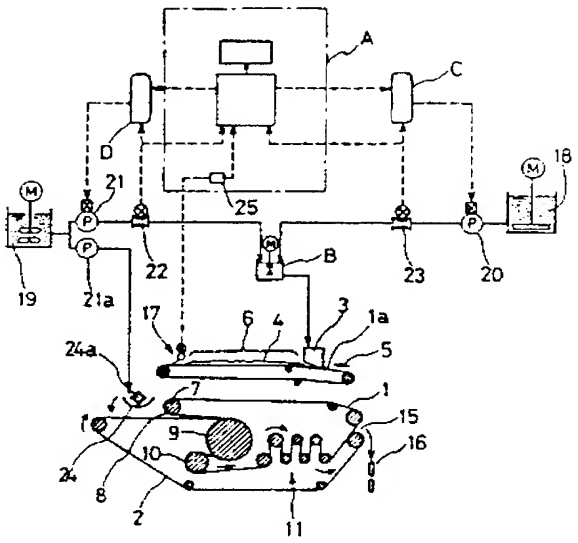
APPLICATION DATE : 07-07-89
APPLICATION NUMBER : 01176368

APPLICANT : KOBE STEEL LTD;

INVENTOR : KITAO YOSHIAKI;

INT.CL. : B01D 33/04 B30B 9/24 C02F 11/12

TITLE : CONTROL METHOD FOR BELT PRESS TYPE DEHYDRATOR AND DETECTING DEVICE FOR ITS SLUDGE THICKNESS



ABSTRACT : PURPOSE: To save the amount of flocculant and to reduce the fuel cost by searching and supplying such supply amount of flocculant that the thickness of flocculated sludge after the dehydration by permeation in a gravity dehydration part becomes minimum under a constant sludge spply rate.

CONSTITUTION: The flocculated sludge 4 obtained by supplying flocculant to sludge is charged on the running filter cloth belt 1a, the free water in the flocculated sludge is removed by permeation in the gravity dehydration part 6, and the sludge after the dehydration by permeation is put between a filter cloth belt 2. The other filter cloth belt 1 is placed upon the former belt to pass on plural rollers 10, 11 to remove the water in the sludge. Under a constant supply rate of sludge, such a supply amount of flocculant that the thickness of flocculated sludge 4 after the dehydration by means of permeation in the gravity dehydration part 6 becomes minimum is searched and the searched amount of flocculant is supplied to the sludge before charged on the filter cloth belt. The supply rate of sludge is controlled so that the thickness of flocculated sludge after the dehydration by the permeation becomes a specified set thickness. As a result, the saving of flocculant and the reduction of fuel cost is realized.

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